

1/ppts

10/534771
JC06 Rec'd PCT/PTO 13 MAY 2005

Description

Linear amplifier arrangement with non-linear amplifier element for a mobile radio device

The invention relates to a method and a device for optimizing the efficiency of an amplifier arrangement with a non-linear power amplifier in a mobile radio device.

As part of the further development of mobile radio from the GSM standard through to EDGE or then further on to the UMTS standard, new demands are being made on the transmission characteristics of power amplifiers. Whereas previously the information was transmitted as pure phase information (GMSK) the amplitude is now also evaluated for information transmission. This results in more stringent requirements for the transmission characteristics of the power amplifiers. On the one hand the amplifier element must be extremely linear and on the other hand the transmission characteristics must not depend on temperature changes and operating voltage variations. This is however as a rule not the case with a transistor. To achieve this measures are thus required for minimizing linear and non-linear distortions. This can for example be implemented in the form of a pre-equalization in the base band or intermediate frequency or in the form of a closed loop such as a polar loop for example. In in each case a significant balancing and/or circuit overhead is required with such an arrangement.

The object of the present invention is to propose an efficient and cost-effective amplifier arrangement.

The object is achieved in accordance with the objects of the independent patent claims. Developments of the invention are specified in the subclaims. A core feature of the invention lies in the fact that in an amplifier arrangement with a non-

linear power amplifier (LV) and two successive push-pull phase modifiers (PS) a signal offset in phase to the input signal is generated in each case. In this case after the phase modifiers power dissipation is converted at a passive component. The passive component is connected to the outputs of the phase modifiers. A passive component can for example be a load balancing resistor or a symmetrical transformer with a subsequent rectifier arrangement. After the power amplifier the amplitude-modulated signal is divided up into two signal parts of equal size or part powers and routed via two push-pull phase modifiers. The use of a symmetrical transformer as the component represents an advantageous embodiment. The voltage uncoupled in the symmetrical transformer in this case is forwarded to a rectifier and the direct current output by the rectifier is routed to a supply unit as charge current. One advantage of this amplifier arrangement is that the efficiency of this arrangement can be decisively improved. Furthermore the method and the arrangement of very cost effective.

The invention will be explained in greater detail with reference to an exemplary embodiment shown in the figures. The individual diagrams show

Figure 1 a power amplifier with subsequent modulation feed and load balancing resistor,

Figure 2 an amplifier arrangement for feeding back electrical energy to a supply unit of a mobile radio device.

Figure 1 shows an amplifier arrangement for implementing a linear amplifier system with non-linear amplifier components. Two phase modifiers PS controllable with one modulation signal are connected after a C-class power amplifier LV (efficiency that can be realized in practice appr. 75%). In principal the circuit works with any class of amplifier (A, B or C), however the efficiency is degraded with an amplifier LV operated other

than in C class mode.

After the power amplifier LV the generated signal or the power PRF is divided up into two part signals or part powers of equal size PRF 1 and PRF 2 and these part powers are routed via the push-pull phase modifiers PS. in accordance with amplitude information the power (RF) is converted as power dissipation in the load balancing resistor LAW. Amplitude information in this case is envelope curve information. The main disadvantage of this circuit arrangement also arises here. Corresponding to the crest factor (ratio of peak power to average power) the C-class power amplifier LV must be arranged for the peak power to be transmitted. However in such a circuit arrangement this leads to a large part of the RF power generated PRF being converted in the load balancing resistor LAW.

Figure 2 shows a amplifier arrangement for feeding back electrical energy to a supply unit of a mobile radio device. The power amplifier LV from Figure 1 can again be seen in this diagram operating in C-class mode with subsequent power separation PRF 1 and PRF 2 and the controllable phase modifiers PS. In principal the circuit works with any class of amplifier (A, B or C), however the efficiency is degraded with a power amplifier LV operated other than in C mode. Omitted from this diagram is the load balancing resistor LAW which is replaced by a symmetrical transformer SÜ (ballun). Furthermore a rectifier arrangement GR connected to a direct current supply unit VE is added. The task of this new circuit arrangement is to route the dissipated power (HF) of the power supply unit (battery, ac adapter etc.) previously converted in the load balancing resistor LAW to a mobile radio device, a mobile station for a cellular mobile radio network, as direct current. After the power amplifier LV the power components PRF 1 and PRF 2 are routed via the phase modifiers PS. The electrical length or the throughput time of the power components PRF 1 and PRF 2 is influenced with these phase modifiers PS. Thus for example

power component PRF 1 is increased in path 1 by phase modifier PS and the delay time in path 2 is reduced by the other phase modifier PS (push-pull). This is conceivable through two vectors which have the same phase angle before the phase modifier PS and are different after the phase modifier PS. This produces a different length of sum vector for the addition of the two subvectors before and after the phase modifiers PS as regards the amount. The phase modifiers PS are controlled by an amplitude modulation signal, which for example can be an audio signal, video signal or similar information. The amplitude modulation signal can be decoupled from the input signal (useful signal). However it can also be any given signal. If the control voltage of the phase modifiers PS is not equal to zero, there is a voltage drop at the symmetrical transformer SÜ. The control voltage corresponds to the amplitude modulation signal and is thus zero when the modulation voltage is zero. Via the symmetrical amplifier SU this voltage is transmitted on the secondary side of the transformer SÜ and referenced there to a potential. In this example this is represented by a ground symbol. A reference to a battery potential for example is however also always conceivable. Subsequently the voltage is rectified with a multipath rectifier and filtering is performed. The greatest possible efficiency is obtained with a multipath rectifier. It would also be conceivable to use another rectifier. The direct current set can then be fed to the supply unit VE. To guarantee the functionality of the overall circuit it is important that the input impedance of the rectifier GR is almost independent of amplitude. If the input impedance of the rectifier is not constant, non-linear distortions are created which affect the function of the overall circuit. To transmit all signal components free of distortion the C amplifier LV must be designed for the maximum peak power occurring to be able to be transmitted. This means that the amplifier LV runs with a constant power which lies

above the average power required at the output by the crest factor. With current normal transmission procedures the crest factor lies in the range 3dB to 10dB. If the amplifier LV is dimensioned for a crest factor of 10dB, this means that for the arrangement with a load balancing resistor LAW (Figure 1), appr. 90 % of the generated power would be converted in the load balancing resistor LAW as power dissipation. With the expanded circuit there is now the opportunity of capturing a this power dissipation component (HF) and feeding it to a supply unit VE as charge current. An HF (power dissipation) - DC (direct current) conversion is thus performed.